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Demand Control Ventilation

California Building Energy Efficiency Standards
Revisions for July 2003 Adoption

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This document presents information necessary to complete a preliminary evaluation of proposed changes to Demand Control Ventilation in the 2005 Building Energy Efficiency Standards. Information provided through this document can be used to identify possible changes to the Standards to be released for comment in July 2002 and adopted in July 2003.

Description

This proposed CASE initiative will seek to expand the current requirement for demand ventilation controls. The current demand controlled ventilation requirement §121 was limited to UBC "high density" occupancies and spaces with fixed seating with less than 10ft2/person and also systems that provide a minimum of 3,000 cfm OSA at design occupancy. Furthermore it is possible to have a single sensor control multiple units eliminating a loophole in the 3,000 cfm threshold (as described in the current Non-Residential Compliance Manual). We also proposing raising the existing requirement for 800ppm control by CO2 based sensors to a requirement for 15 cfm per person. These changes would affect large commercial buildings with both constant air volume systems.

Benefits

The existing limits on density and system size were arbitrarily provided to give the industry some time to adjust to a new requirement for demand controlled ventilation (DCV). Extending DCV to lower density occupancies and smaller system sizes would increase the amount of time that those systems were operating at minimum air flow, thus saving energy and reducing peak demand. In addition, zone-based controls would reset the minimums of VAV boxes based on zone demand and reduce energy used for overcooling and/or reheat.
Since the studies of this measure assume that savings are spread equally throughout the day, Time Dependent Valuation (TDV) is not likely to have much of an impact on this measure.

Environmental Impact

This measure has no adverse environmental impacts. Water consumption is not increased. Indoor air quality is maintained (consistent with current interpretations of ASHRAE Standard 62).

Type of Change

The proposed change is a mandatory measure.

Mandatory Measure	The change modifies a mandatory measure. Mandatory measures must be satisfied with either the prescriptive or performance compliance methods.

The proposed change expands the scope an existing requirement.

Title 24, section 121 needs to be modified in order to implement the proposed change. Some numerical values need to be altered and brief additional text provided. No changes are anticipated for either the ACM Manual or compliance forms.

Measure Availability and Cost

A principal manufacturer of CO2 sensors is Telaire Inc. in Goleta, California. Their products are available directly from the manufacturer and are also handled as OEM products by many of the major HVAC equipment and control companies. Other manufacturers also make CO2 sensors and it is anticipated that the manufacturing base can easily handle any increased demand for sensors resulting from the Standards change. Currently, CO2 is the industry's best proxy for ventilation demand - there are no competing product types that satisfy the measure requirements.
The baseline condition (for spaces with more than 10ft2/person and systems with less than 3,000 cfm OSA at design occupancy) is that ventilation demand is met based on minimum outside air requirements for an assumed occupancy. If that assumed occupancy is not actually in the space, the space is over-ventilated and energy is used unnecessarily. For life cycle cost analysis, the measure will be compared to the baseline condition defined by common practice.
A typical CO2 sensor costs roughly $500. Commissioning costs are insignificant.

Useful Life, Persistence and Maintenance

The useful life of a CO2 sensor is expected to be in excess of ten years. Energy savings related to this measure will persist indefinitely as long as the sensor remains in calibration. With self-calibrating sensors drift is of little concern.

Performance Verification

The need for performance verification with the Telaire sensor is minimal. The sensors are self-calibrating and presently guaranteed against drift for 5 years.

Cost Effectiveness

The proposed change is likely to be cost effective for many climate zones. The measure will be shown to be cost effective through life-cycle cost analysis. Simulations will be used to generate annual energy consumption in all California climates. The annual heating and cooling energy amounts for each run will be converted to a net present value dollar amount. With these values, the energy cost for the larger and smaller outdoor air minimum cases is calculated. The difference between the cases represents the dollars that would have been saved if the system ran for an entire year at the minimum position. A payback breakpoint is calculated by taking the ratio of the additional first cost of the demand-controlled ventilation equipment and dividing it by the dollar difference between the two cases.
This breakpoint can be interpreted as the percent of hours where the system is in operation where the outdoor air minimum is set to the low threshold. During the remaining hours, the outdoor air minimum position can be assumed to be at the higher setpoint.
To determine the threshold level below which the measure makes sense for a climate zone, a non-residential occupancy schedule is converted to equivalent full occupancy hours for a year. The unoccupied percentage of the system operating hours is then calculated and compared to the threshold unoccupied percentage for each climate zone. Where the climate zone percentage is below the threshold percentage, the measure makes sense for a zone.

Analysis Tools

The tools needed to quantify energy savings are building energy use simulations, occupancy models and life-cycle cost analysis. Thirty two simulations (sixteen climate zones and two occupancies) will be used. The building model will be consistent with Title 24 envelope measures across the 16 climate zones in California. Constant volume single zone systems will be used. The two occupancies will determine the outside air requirements in the simulation. The higher outdoor air minimum is determined by the Title 24 (§121) requirement of 15 cfm/person while the lower outdoor air minimum is determined by using the Title 24 (§121) demand-controlled ventilation floor of 0.15cfm/ft2

Relationship to Other Measures

No other measures are affected by this change

Bibliography and Other Research

Recent studies including an ASHRAE Standard 62-1999 Addendum indicate that for sedentary occupants a CO2 based demand ventilation control setting of ~1,100ppm would provide the equivalent of 15 cfm per

person. The existing 800ppm requirement would cause over ventilation of most zones utilizing demand ventilation controls. The CEC staff is aware of this but they are reluctant to change the requirement without support from an environmental impact report. Members of the industry (including Carrier and Telaire) have indicated that they may contribute to this effort. We propose to spearhead this effort as part of this initiative.

There are also a number of peer reviewed articles in the ASHRAE Journal and papers in ASHRAE Transactions.

Schell, M.; Int-Hout, Dan. Demand Control Ventilation Using CO2. ASHRAE Journal February 2001. Atlanta GA.